

CECW-EW

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Engineering and Design
RELIABILITY ANALYSIS AND RISK ASSESSMENT
FOR SEEPAGE AND SLOPE STABILITY FAILURE MODES
FOR EMBANKMENT DAMS**

1. Purpose

This document provides guidance for performance of risk assessment analyses of dam safety-related detrimental seepage (internal erosion, piping, under seepage, and heave) and slope stability problems. Detailed descriptions of reliability and risk analysis for seepage and slope stability problems are provided.

2. Applicability

This ELT is applicable to all USACE Commands having Civil Works Responsibilities. It applies to all studies for major rehabilitation projects.

3. References

See Appendix A.

4. Distribution

Approved for public release, distribution is unlimited.

5. Discussion

a. Risk assessment is performed to evaluate various parameters to assist in the decision making process. A risk analysis and assessment provides the total annualized consequences or risk with and without the proposed seepage/stability correction project. By comparing the with and without projects, the risk assessment process is used to guide the selection of the alternative that is most effective in reducing the risk of unsatisfactory performance.

b. Site characteristics and potential modes of failure are identified. An event tree is then used to describe the various modes of unsatisfactory performance, and weighted

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damages are determined by multiplying the probabilities of occurrence and the costs incurred to give expected risk. Once the risk is determined for the without-project condition, the process is repeated for each with-project alternative. The most feasible alternative can then be selected.

c. The above methodology is used to assess seepage risk analysis and slope stability risk analysis.

d. Practical examples and case histories on the application of reliability analysis and risk assessment for seepage and slope stability failure modes of embankment dams are presented in the appendices to this ETL as follows:

- Appendix A lists the references used in this document.
- Appendix B discusses Poisson distribution.
- Appendix C provides a discussion of the six-sigma rule.
- Appendix D is a step-by-step reliability analysis of a slope stability problem.
- Appendix E is guidance on performing expert elicitation.
- Appendices F and G are case histories on applying risk analysis to projects with seepage problems.
- Appendix H provides information on using a historic data model to analysis piping in an embankment dam.
- Appendix I is a case history of a slope stability reliability analysis.
- Appendix J is a case history of historical frequency of occurrence model for pipes.
- Appendix K discusses Monte Carlo simulation.

FOR THE DIRECTOR OF CIVIL WORKS:



11 Appendices
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